

## DISASTER IMPACT ON SUNDARBANS - A CASE STUDY ON SIDR AFFECTED AREA

MOHAMMAD ZAKIR HOSSAIN KHAN

Institute of Disaster Management and Vulnerability Studies, Dhaka University, Bangladesh

### ABSTRACT

The primary indicators of environmental sustainability is the biodiversity and its conservation stated by Kates et al. (2001), whereas the assessment of biomass and floristic diversity in tropical forests has been identified as a priority by many international organizations stated by Stork et al. (1997). Cyclone 'Sidr', a tropical cyclone, was one of the biggest cyclones in the history of Bangladesh, formed in the central Bay of Bengal hit the coast of Bangladesh in 2007 and it made landfall on 15th of November with peaking wind speed of over 260 km/h. It resulted in an estimated 4,000 human deaths and the displacement of over 3 million people stated by US Embassy Dhaka (2007). The most significant devastating impact it left behind is on the diversity of flora of the Sundarbans. One quarter of the biomass cover (which is approximately 2500 sq. km) of the Sundarbans mangrove forest was damaged by the storm directly or indirectly due to the tidal surge stated by CEGIS (2007). The study shows that the total forest area damaged by the cyclone Sidr was about 21% of the Sundarbans. It was found that highly affected forest areas were dominated by Keora (*Sonneratia apetala*). Trees of Keora are comparatively taller more than 15 m and grow on newly accreted forest land. Moderately affected areas were dominated by Sundri (*Heritiera fomes*) and Gewa (*Excoecaria agallocha*). They are medium range from 10-15 m to small 5-10 m trees. Slightly affected areas were identified along the river banks and in the northern part of Sundarban. They were mainly Gewa dominated areas with comparatively smaller trees.

**KEYWORDS:** Primary Indicators of Environmental Sustainability, Diversity in Tropical Forests

### INTRODUCTION

The primary indicators of environmental sustainability is the biodiversity and its conservation stated by Kates et al. (2001), whereas the assessment of biomass and floristic diversity in tropical forests has been identified as a priority by many international organizations stated by Stork et al. (1997). Bangladesh has only 18% (2.58 million ha) of forest coverage. On the basis of geographical location, climate, topography and management principles, the forests can broadly be classified into: hill forests, mangrove forests, plain land sal forests, unclassified state forests, and homestead forests stated by Motiur (2006). The Sundarbans is a natural region in Bengal, South Asia. 'Sundarbans' is a Benglai language and meaning is 'beautiful forest'. It is the single area of tidal mangrove forest in the world, lies in the natural delta of the Ganges, the Brahmaputra and the Meghna. It is a UNESCO World Heritage Site.

The Sundarbans lies in the vast delta on the Bay of Bengal formed by the siltation from the Padma, Brahmaputra and Meghna rivers across southern Bangladesh. The Sundarbans has extremely rich diversity of terrestrial and aquatic flora and fauna. Mangroves are associated with flowering plants, palms, ferns, bryophytes, fungi, algae, lichens and bacteria. About 334 plant species, including 35 legumes, 29 grasses, 19 sedges, 18 euphorbia and 50 true

mangrove plant species were recorded by Chaffey et al (1995). Mangrove forests are habitats to about 500 species of wild vascular plants, stated in FAO (2004). A mentionable amount of economically important plants are found in this forest. Macintosh & Ashton (2002) stated that fauna have been poorly studied in comparison to flora, but according to FAO estimates, Sundarbans mangrove forest is home to ca. 840 species of wild animals, including. 419 Royal Bengal tigers stated in MoEF (2004). Within the forest habitats, there are ca. 50 species of mammals, ca. 320 species of inland and migratory birds, ca. 50 species of reptiles, eight species of amphibians, ca. 400 species of fish, as well as insects. Mangroves are also the nursery and/or breeding grounds for several commercially important species of aquatic fauna stated by Saenger (2002). Among the invertebrates some molluscs and crustaceans constitute important fisheries resources. Pasha & Siddiqui (2003) stated that, about 20 species of shrimps, 8 species of lobsters, 7 species of crabs, several species of gastropods, and 6 species of pelecypods have been reported from the Sundarbans. Seidensticker & Hai (1983) stated that, over 120 species of fish are said to be commonly caught by commercial fishermen. A large number of economically important plants are found in this forest.

The main goal of this study is to carry out a comprehensive assessment on Sidr affected area on Sundarbans. The main objective of this study is to assess the conditions of ecosystem, biodiversity, causes of loss of natural resources, salinity intrusion and other related factors due to Sidr in the Sundarbans area.

## METHODS AND MATERIALS

The study was conducted through secondary data collection of different institutional and newspaper reports. After the data collection and analysis phase is completed.

The Sundarbans is located at 21°30'- 22°30'N, 89°12'-90°18'E. Area of the Sundarbans is approximately 10,000 km<sup>2</sup> of which 60% is located in Bangladesh with the remainder in India. The area of the Sundarbans in Bangladesh is 5,950 km<sup>2</sup> of which 1,396.99 km<sup>2</sup> are protected as follows: Sundarbans West Wildlife Sanctuary with 715.02 km<sup>2</sup>; Sundarbans East Wildlife Sanctuary with 312.26 km<sup>2</sup>; and Sundarbans South Wildlife Sanctuary with 369.70 km<sup>2</sup>. Sundarbans National Park (1,330.10 km<sup>2</sup>), a World Heritage Site, is situated to the west in India. Sundarbans is located in Khulna division in Bangladesh area; nearest cities are Khulna, Satkhira and Bagerhat. It's South, East and west is three protected forests in Bangladesh.

Secondary data's such as statistical data, reports, maps collected from various Government and Non-government organizations like Department of Environment (DoE), Dhaka, Department of Forestry (DoF), Dhaka, Sundarbans Biodiversity Conservation Project (SBCP), Khulna, Khulna Forest Office, Relevant papers and reports of International Organizations through internet search, Journals and papers relevant to the study from NGO's, Seminar library of Urban and Rural Planning Discipline. Collected information's were processed, analyzed and interpreted to find the result the study.

## RESULTS AND DISCUSSIONS

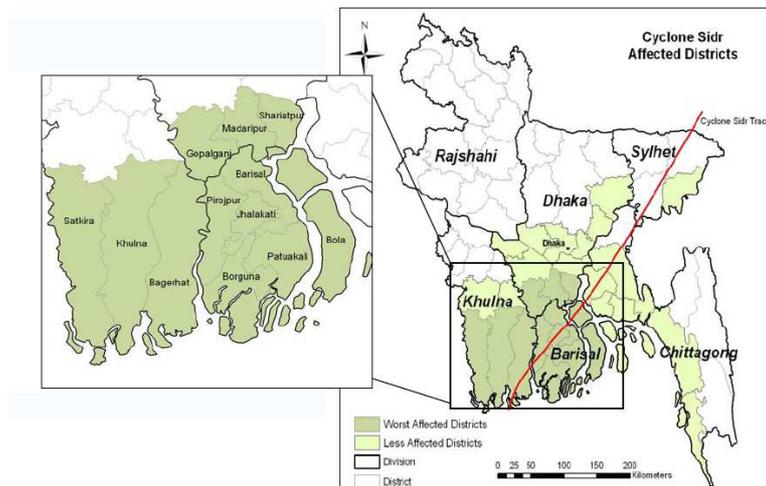
In November 2007, cyclone Sidr struck and followed track to its two major predecessors and devastated area of the country. The estimated casualty figure of 4,234 deaths stated by EM-DAT (2008a); reflects a hundredfold improvement over the preceding 37 years. Sidr began to develop on 9 November 2007 before being upgraded to a "cyclone" on 12 November 2007, a "severe cyclone" later that day, and a "very severe cyclone" early on 13 November 2007. It reached its peak strength on the morning of 15 November 2007 before making landfall at around 6.30pm local time across an area of

some 1,000km in diameter. The arrival of the cyclone was accompanied by heavy rain and a storm surge of some 10-15 feet (3-5 metres) although, fortunately, it struck at low tide otherwise the effects would have been greater still, stated by GoB (2008).

Some 35M people (20%) of the population live in the 19 coastal districts of Bangladesh which have a resulting high population density of some 1000 persons/sq km. Many of these people live on off-shore islands known as “chars” (meaning “children of the land”) which have been created by the silt that flows down the main rivers (the Padma (Ganges), the Brahmaputra, and the Meghna), as well as over 230 lesser ones). The chars are, typically, less than 3 feet (1 metre) above sea level and have very limited forestation leaving them vulnerable to cyclones, and it was areas such as these that took the main force of Cyclone Sidr shown in figure 1.

### Synopsis of Cyclone Sidr

- **Formed** November 11, 2007
- **Enter to land** November 15, 2007
- **Dissipated** November 16, 2007
- **Highest winds** 215 km/h (130 mph)
- **Lowest pressure** 944 hPa (mbar)
- **Fatalities**  $\geq 3,447$
- **Damage** \$450 million (2007 USD)
- **Areas affected** Bangladesh and West Bengal, India



**Figure 1: Districts of Bangladesh affected by Cyclone SIDR. (Source: GoB, 2008)**

The Sundarbans mangroves and coastal forests importance, as effective barriers to cyclones, became obvious during cyclone Sidr. Devastation to inland assets and livelihoods losses could have been much more severe without their acting as barriers. Due to the absence of market information, a full economic assessment of the damages to these resources

was not possible.

The Sundarbans comprising the southern part of the Satkhira, Khulna, and Bagerhat districts is the largest mangrove ecosystem of the world. The Sundarbans are familiar for its wide range of flora, fauna and aquatic life. More than 270 species of birds, 35 species of reptiles, and 42 species of mammals (including the famous royal Bengal tiger), and 400 species of fish are recorded. Three wildlife sanctuaries covering an area of 139,700 ha were declared a World Heritage Site in 1997. It extends 80 km north of the Bay of Bengal and is bound on the east by the Baleswar River and on the west by the border with India. The Sundarbans covers some total 590,000 hectares. A coastal afforestation program has been in place since 1960, covering mainly newly accreted coastal land, the riverine coastal belt, and abandoned embankments. These plantations have played a significant role in reducing the impact of previous cyclones and floods. Their effectiveness as a barrier to cyclones depends on the width of the plantation, the number of stems per unit area, the size of the trees, the effect of branches and the roughness of the land. Coastal afforestation programs have covered about 159,000 ha. Moreover, social forestry programs introduced by the Forest Department, in areas such as encroached and degraded forests, roadsides, char land, and other marginal lands, have increased green coverage and created employment opportunities. Through 2002, a total of 111,650 ha of lands had been brought under reforestation since 1990.

Sidr hit the eastern part of the Sundarbans, especially Dublar Char, Kotka, Kochikhali, Hiron Point, Sharankhola, and the Chandpai area, causing severe destruction within 300 m of riverbanks. Satellite imagery reveals that the cyclone covered about 30% of the Sundarbans. The severe ecosystem disruption included uprooted, broken and twisted plants, and burnt foliage. The Forest Department estimated that about 30,000 acres of forest resources were severely affected and another 80,000 acres were partially affected. National and UN organizations participated in the preliminary assessment of the damage following Sidr. Space Research and Remote Sensing Organization (SPARRSO), and Centre for Environmental and Geographical Information Services (CEGIS) reported 19% and 31% of the Sundarbans was damaged, respectively (SPARRSO, 2007; CEGIS, 2007). UNESCO reported 30% damage (UNESCO, 2007).

The flora species of the Sundarbans is composed mainly of halophytic tree species. The eastern part is mainly dominated by Sundri and Gewa, which were affected by cyclone Sidr on 15 November 2007.

In the partially affected areas, many branches were broken but the main trunks of the trees remained intact. The impact on dominant plant species—Sundri (*Heritiera fomes*), Gewa (*Exococaria agallocha*), and Keora (*Sonneratia apetala*)—was severe. An UNDP-sponsored report showed that Keora was the most affected plant species (80 percent) among all those affected in a total of 47,211 acres (Source: Rapid Environmental Assessment in the Sidr Affected Areas: A Joint Assessment by FD, DoE, CEGIS, SPARRSO and UNDP, 2008). The forest department estimated total forest resources damaged in the affected 110,000 ha are about BDT 10 billion (The accuracy of these numbers is not confirmed. Calculation is based on BDT 400 ~ BDT 250, since market values do not exist, these values is difficult to confirm).

The disruption to the normal Sundarbans ecosystem functions was extensive. Damaged and broken trees restricted the movement of animals, prevented regeneration capacity, and lead to scarcity of food. Fifty seven ponds of varying size the source of drinking water for local animals were contaminated by saline water. The monitoring and surveillance facilities of the forest department have been severely destroyed, including many old, outdated infrastructure facilities and boats used by the forest department to patrol and monitor the area. All ninety-four administrative units were seriously affected with nearly all of the offices and residential buildings in the eastern part of Sundarbans totally or partially

destroyed.

Coastal forests act as a natural barrier to reduce wind velocities (protecting embankments and settlements) was evidenced. Many coastal forests were heavily affected by the uprooting of millions of timber and fruit trees, nurseries were destroyed, and hundreds of miles of roads and embankments with planted trees on the slopes were eroded. According to the Forest Department, 3,500 ha of coastal forest, 502 miles of strip plantations and 3.1 million nursery seedlings were affected in the coastal areas. The physical damage includes 3362 miles of strip plantation, 78 ha of char land plantation and nursery seedlings.

The Sundarbans absorbed the main blow of the Sidr, saving human lives by slowing down the nature's wrath. According to the forest department, One fourth of the Sundarbans forest area had been damaged by the cyclone Sidr. Eight to ten percent of the forest had been damaged completely, while fifteen percent has been partly damaged published in The Daily Star, 20 November 2007.

The Sundarbans is known as the home of the Royal Bengal Tigers, already an endangered animal, as well as of many other species like spotted deer which are on the verge of extinction. The Forest Department is yet to make an assessment of the colossal losses of wildlife in the Sundarbans.

Cyclone Sidr caused tremendous damage to wildlife. The loss of wildlife is either due washed away by the cyclone and tidal surges or fall under the broken trees. The Dead animals may cause environmental hazards to the remaining herbivores and other wildlife. The cyclone damaged and broken trees restrict the movement of wildlife caused scarcity of fodder due to loss of regeneration in the forest floor. As the existing ponds in the Sundarbans have been infested with the salt water, safe drinking water for the animals is not available.

More than a million people living around the Sundarbans depend on this forest for their livelihood. The forest is an environmental shield for the people living in the country's southwestern region. The rivers in the estuary of the Sundarbans hold more than 200 species of fish including Hilsha, Fatty Catfish, Bass, White Grunt, Eel Tail Catfish, Indian Salmon, Crocker, Scats, Mulletts, Ribbon Fish, Bombay Duck, Anchovys etc. published in The Daily Star 17 November 2007. Besides, these rivers are the sanctuary of various types of shrimps like tiger shrimps, giant fresh water prawn, Indian white shrimp, green tiger shrimp, brown shrimp etc.

The study shows that the total forest area damaged by the cyclone Sidr was about 21% of the Sundarbans. It was found that highly affected forest areas were dominated by Keora (*Sonneratia apetala*). Trees of Keora are comparatively taller more than 15 m and grow on newly accreted forest land. Moderately affected areas were dominated by Sundri (*Heritiera fomes*) and Gewa (*Excoecaria agallocha*). They are medium range from 10-15 m to small 5-10 m trees. Slightly affected areas were identified along the river banks and in the northern part of Sundarban. They were mainly Gewa dominated areas with comparatively smaller trees.

## RECOMMENDATIONS

Coastal afforestation protects embankments against cyclonic surge and monsoon waves with the tremendous additional benefit of greatly reducing the impact of the storm surge observed by the cyclone Sidr and other cyclones. For protection against future disasters and to provide income opportunities for local people through co-management of the

programs, further green the coastal belt are needed. That will include a carefully designed and targeted public involvement and education campaigns. Furthermore opportunities for carbon sequestration should be explored for additional resources. Restoration program of the Sundarbans should be undertaken based on the studies carried out in the medium term. The sustainable development of the Sundarbans will ensure a favorable environment for flora and fauna, as well as watershed protection and nature preserve management.

Strong embankment is one of the capacities to withstand against storm surge. Embankment and Polder in Bangladesh seem to have the following weakness.

- Embankments and Polders do not provide the enough heights to prevent overtopping of cyclone storm surge.
- Accuracy of construction for the side slope and surface of the structures is low. Irregular undulation is seen at any places.
- Many trees are planted in the surface layer of embankments and polders. A large number of these trees were blown down by the strong wind to cause the overturning or uprooting and the failure of embankment body.
- Maintenance for the structures has scarcely been executed.
- Illegal habitation on the structures.

The followings should be considered to strengthen the embankments and polders.

- Present coastal embankments are besides effective against cyclone storm surge not only to normal high tide. However, they will involve a risk of failure by overtopping of a surge or a flood.
- The action plan to make all embankments reconstruct with higher bank enable to prevent a storm surge seems to have several problems in the present time such that the related infrastructures are not fully provided. When considered the nature of bank materials, the present compaction technique for soil, the accuracy control technique, the level of maintenance, the agricultural state in polder lands and the quick drainage system for inundation area so on, the plan to make all embankments enlarge would be seen difficult to be executed.
- Embankments and polders should be strengthened with geo-textile or local productive materials like jute. Proper compaction and vegetative protection to the bodies will be effective.
- Bank protection with stonemason or concrete block would not be reasonable in use in Bangladesh, since the stone and concrete block are rarely produced and need high cost.
- It will be worthwhile constructing secondary embankments parallel to the present embankments, those are expected in flood storage and energy decay of storm surge. The bounded land by two embankments could be used for a farm field.
- Shorefront rooms are remained or newly formed in several places of the coastal area. It is effective for prevention and mitigation to a storm surge, to make new coastal vegetation zones at the places together with conserving the present coastal vegetation zones. Construction as local disaster prevention can be developed. Synthetic measures should be planned with considering the relation between embankments, roads, upping of residential land, channel network and culverts so on. A surrounded land by embankments and roads should be appropriated for a retarding

basin.

- Computer simulation techniques should be used more practically for the land administration to achieve the purpose.

## CONCLUSIONS

In November 2007, cyclone Sidr struck and followed track to its two major predecessors and devastated area of the country. The estimated casualty figure of 4,234 deaths. Sidr began to develop on 9 November 2007 before being upgraded to a “cyclone” on 12 November 2007, a “severe cyclone” later that day, and a “very severe cyclone” early on 13 November 2007. It reached its peak strength on the morning of 15 November 2007 before making landfall at around 6.30pm local time across an area of some 1,000km in diameter. The arrival of the cyclone was accompanied by heavy rain and a storm surge of some 10-15 feet (3-5 metres) although, fortunately, it struck at low tide otherwise the effects would have been greater still.

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